



**Long-term health effects of life-style interventions  
and other applications of the Dutch Chronic  
Diseases Model.**

**National Institute of Public Health and the environment, the  
Netherlands**



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  - Long-term health effects of lifestyle interventions
  - Life-time health care costs for three hypothetical cohorts
  - Long-term health effects of lipid-lowering treatment for persons with diabetes

# POLICY QUESTIONS

- What happens in the future (projections)
  - What is the expected future population size
  - What is the expected future number of persons with diabetes
  - What are the expected future health care costs related to stroke
- What happens to the projected outcomes if... (scenarios)
  - All smokers stop smoking
  - The prevalence of obesity continues to increase
  - We implement a lifestyle intervention
  - We give lipid-lowering treatment to all our diabetes patients
  - Adherence to treatment guidelines improves
- Economic evaluations
  - Are interventions cost-effective

# Long-term policy aims / ambitions

For example:

A maximum increase in the number of people with diabetes of 15% in the next 20 years

or

At most 27% current smokers in 2025

- Are the ambitions feasible
- Which interventions do we need to realize these aims
- On which scale do we have to implement these interventions
- What would it cost
- Would it be cost-effective

# Chronic Diseases Model (CDM)

- What kind of model is CDM

CDM is a multi-state Markov-type simulation model

- What does the CDM do

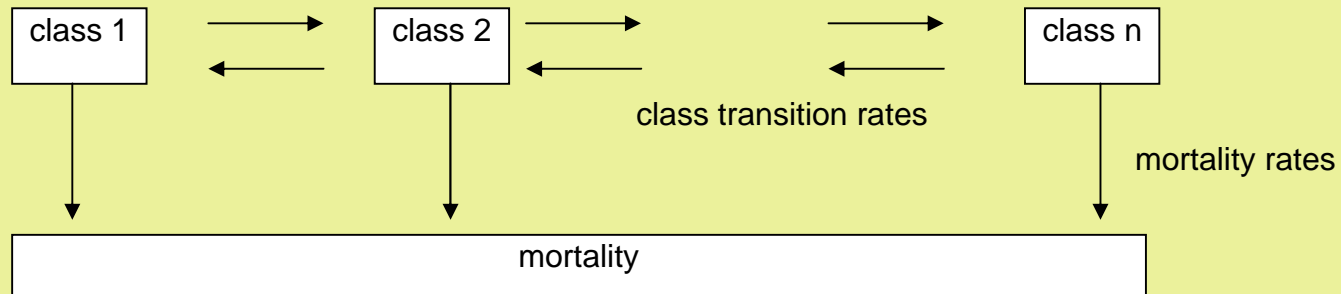
CDM simulates developments in the Dutch population over time with respect to population size, risk factor distribution and prevalence of chronic diseases

- How does it work

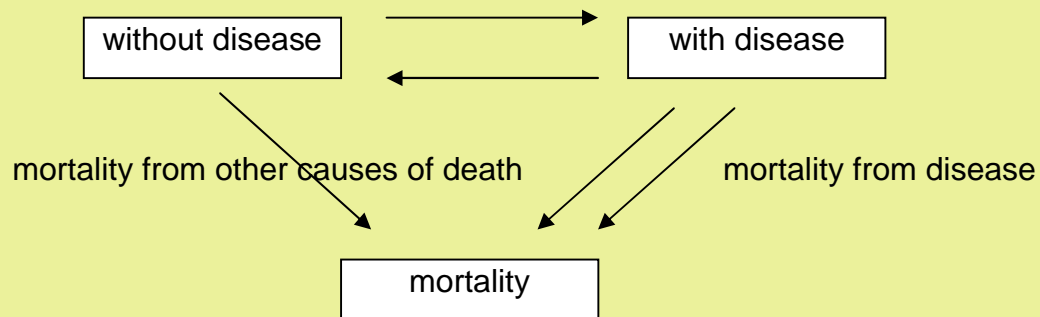
- The model combines information from different data-sources
- The model starts with a cohort, resembling the Dutch population
- Model states are defined by risk factor class and by disease state
- Change of state prevalence rates are modeled through transitions
- Disease incidence rates depend on risk factor levels
- Mortality rates depend on disease status

# State-transition structure of CDM

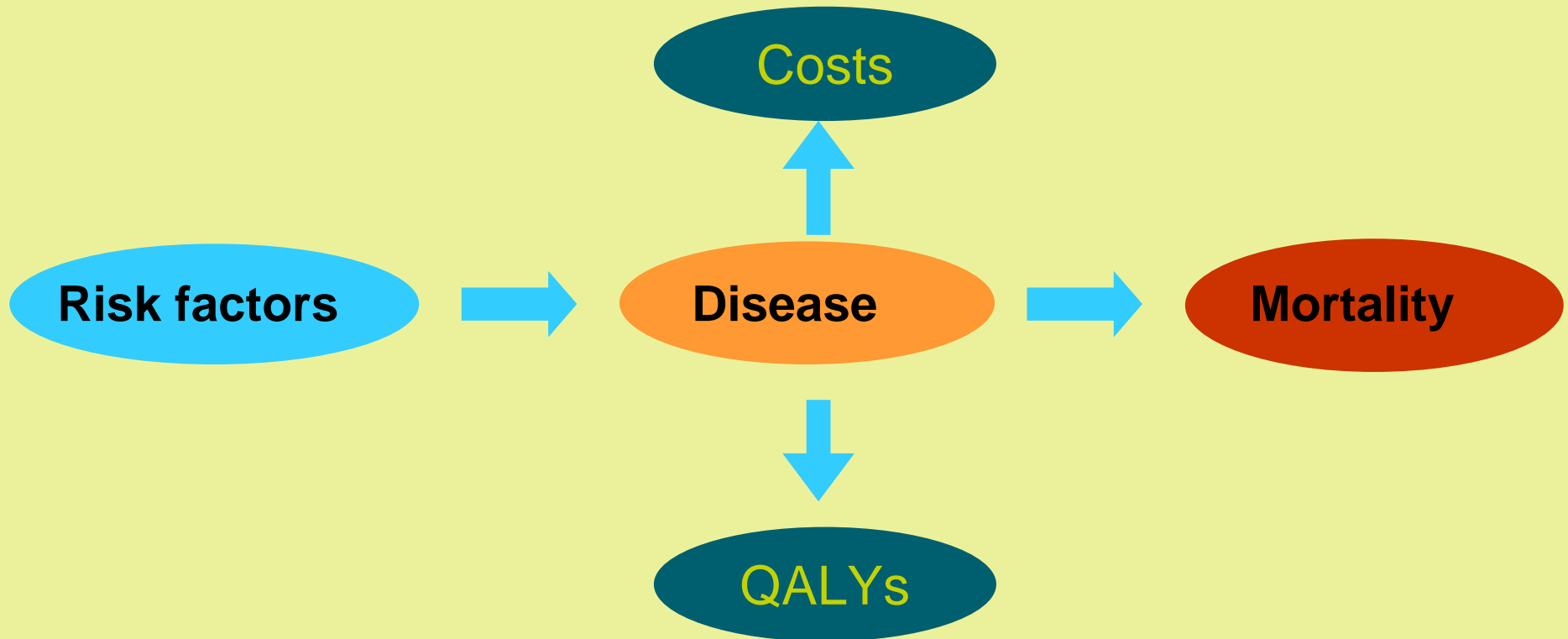
Transitions between risk factor classes



Transitions between disease states

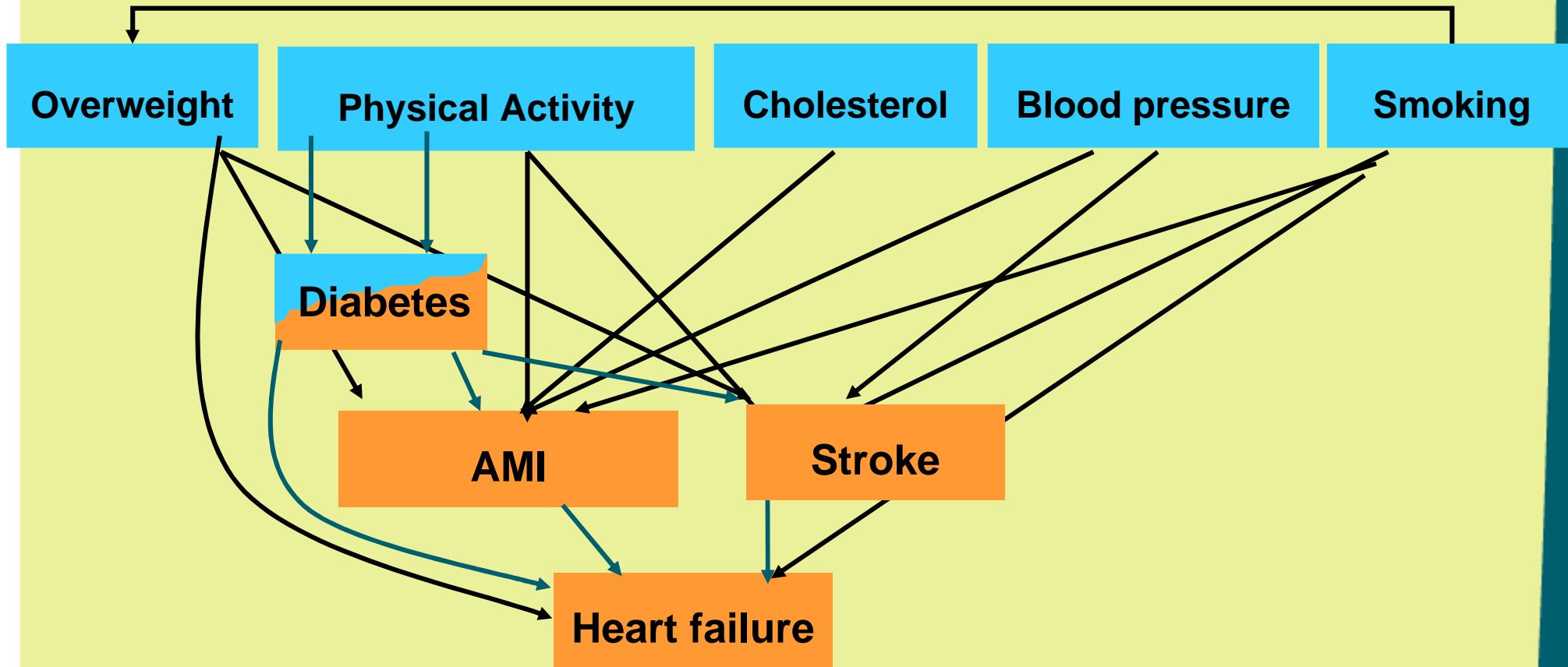


# MODEL STRUCTURE



Follows Dutch population through time

More complex



# Content

- **12 risk factors**

- Smoking
- Overweight (BMI)
- Physical Activity
- Blood pressure
- Cholesterol
- Alcohol
- Nutritional risk factors (5)
- Blood glucose (HbA1c)

- **28 chronic diseases**

- Cardiovascular diseases
- Respiratory diseases
- Cancers
- Musculoskeletal diseases
- Diabetes Mellitus
- Dementia

# Data sources:

- Disease incidence, prevalence and mortality :

GP registrations, Statistics Netherlands, Cancer registries

- Risk factor behavior:

cohort studies, monitoring studies

- Relative risks:

international literature

- Demographic data:

Statistics Netherlands

- Cost of Illness:

Cost of Illness Study in the Netherlands

- Quality of Life:

Dutch Burden of Disease Study

# Outcomes

- Mortality / population size
- Life years / life-expectancy
- Prevalence of chronic diseases
- Quality adjusted life-years
- Health care costs
- Cost-effectiveness ratio

# Example 1: Life-style interventions

## “Community intervention”:

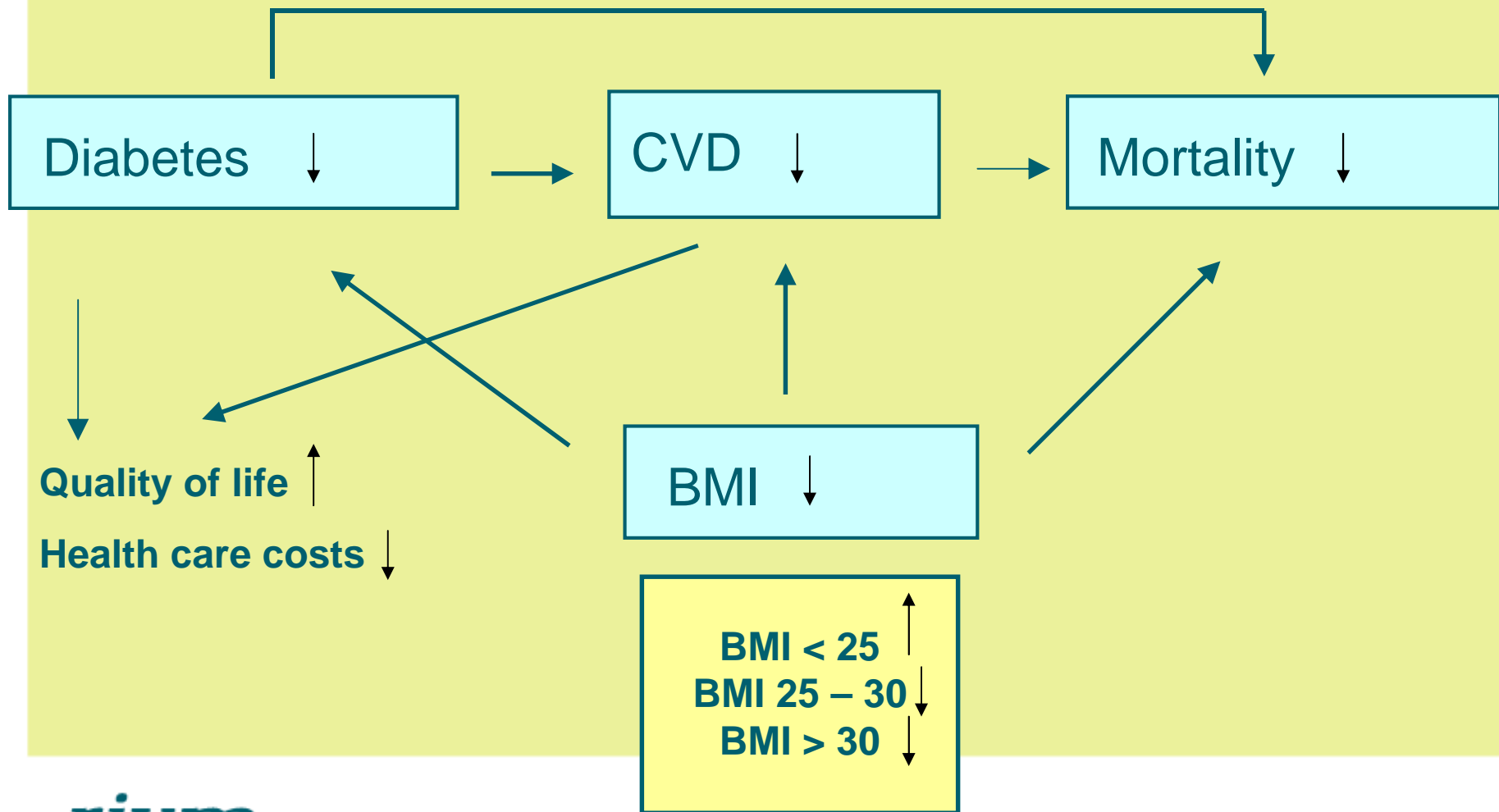
Life-style intervention for the general adult population  
assumption based on available evidence:  
average body weight decreases by 0.7 kg

## “Health care intervention”:

Intensive lifestyle intervention for obese adults  
assumption based on available evidence:  
average body weight decreases by 4.5 kg

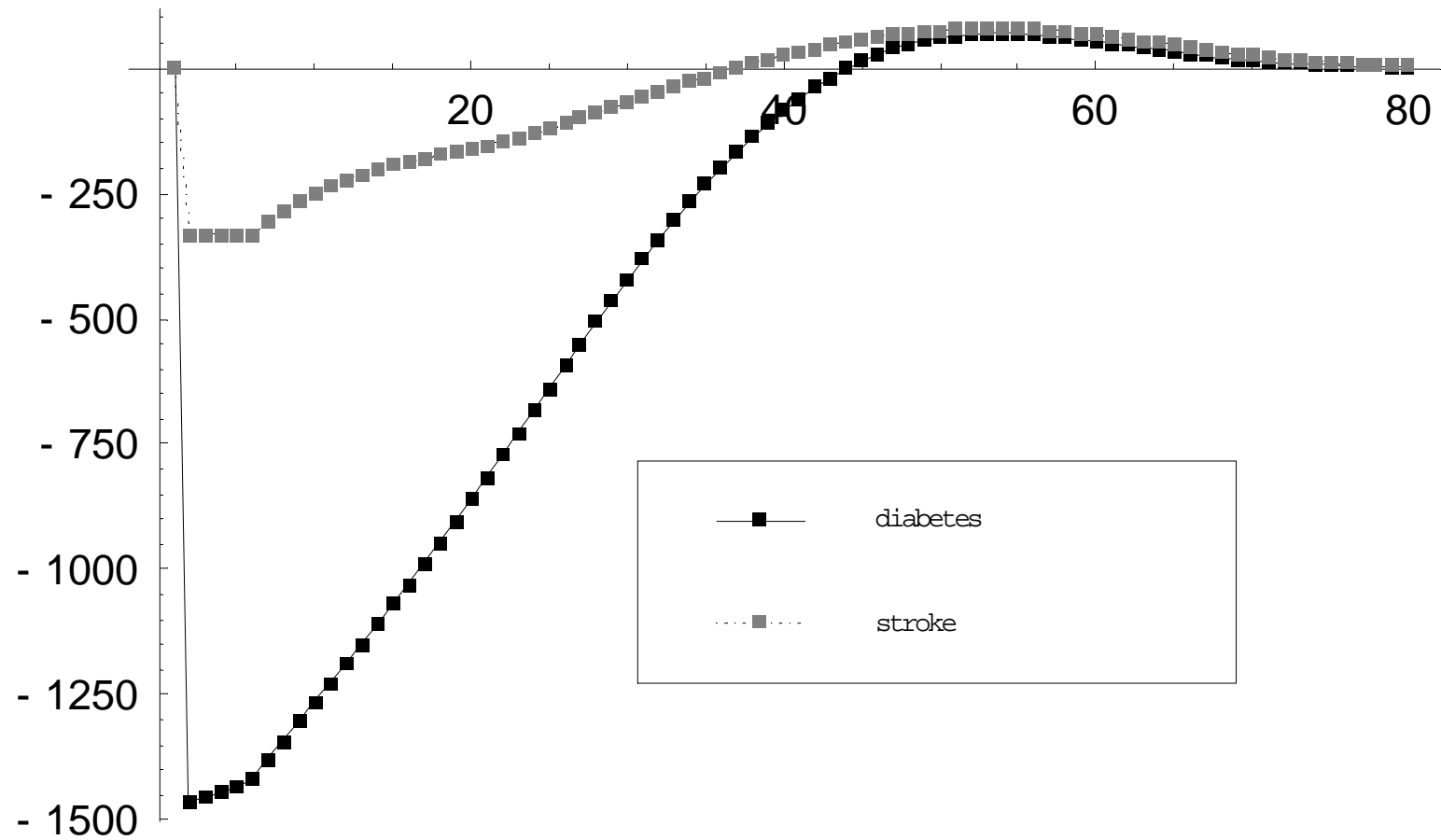
Jacobs et al. 2007

# What happens ?



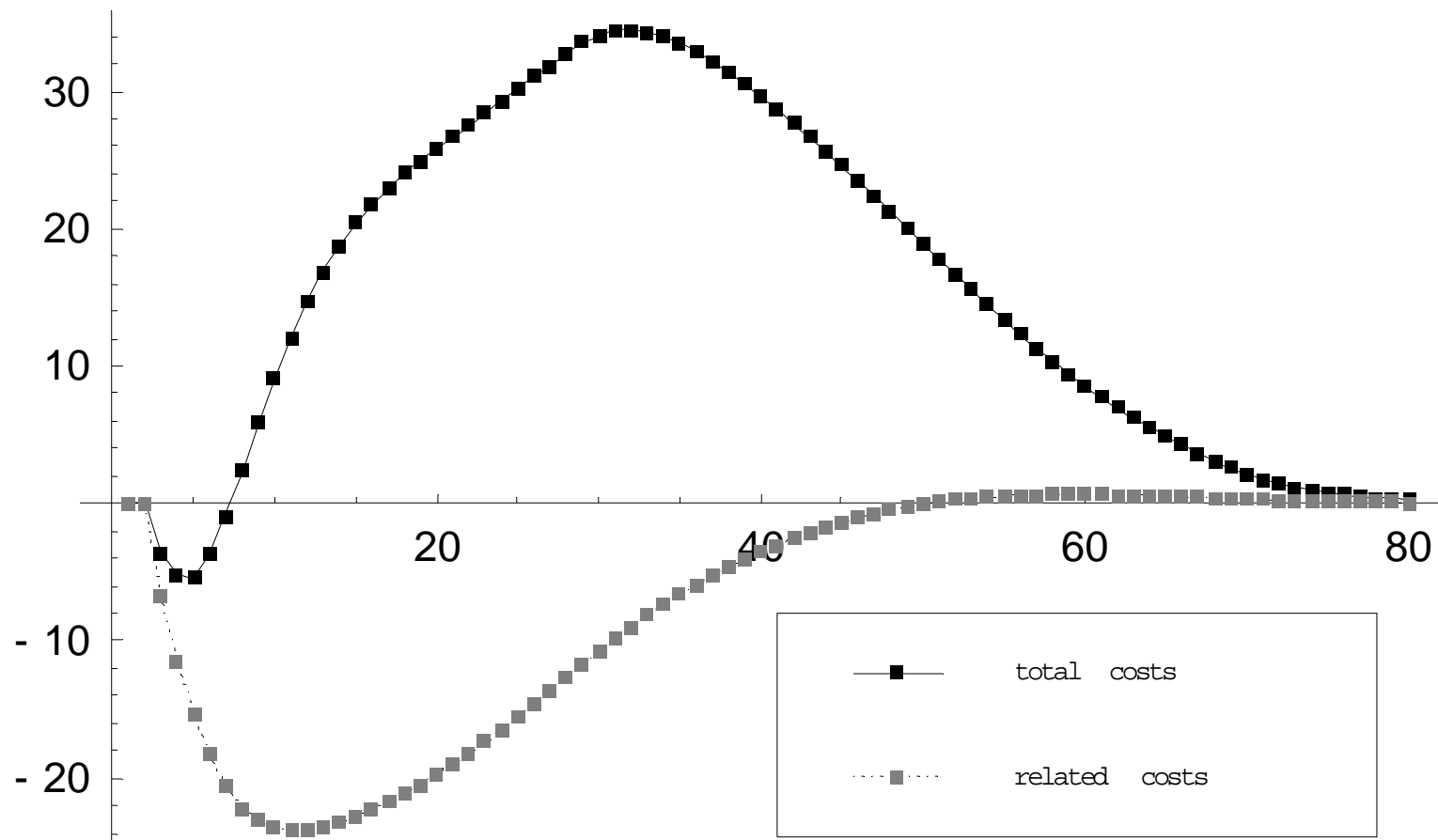
# Results for disease incidence

disease incidence



# Results for health care costs

Costs \* €million



# Results:

## Community intervention

for the total Dutch general adult population, 12 million

- NNT in order to prevent one new case of diabetes: 300
- diabetes incidence: - 2,4% / CVD incidence: - 0,7%
- intervention costs: 72 million euro
- 3000-4000 €/ QALY

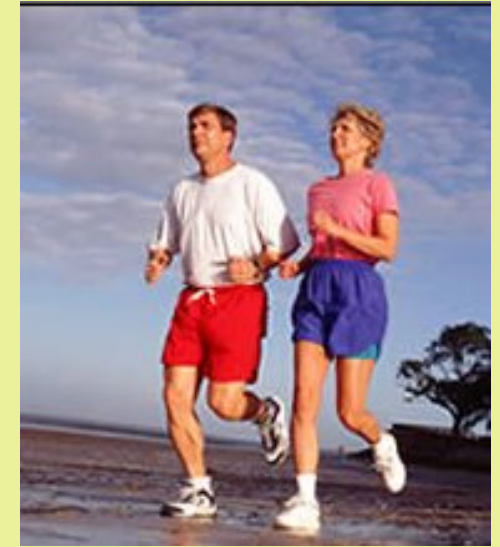
## Health care intervention

for 1 million obese Dutch adults

- NNT in order to prevent one new case of diabetes: 300
- diabetes incidence: -1.6% / CVD incidence: - 0,3%
- intervention costs: 140 million euro
- 4000-6000 €/ QALY

# Example 2: Estimate annual and lifetime health care costs of three different cohorts

1. 'Healthy living' cohort



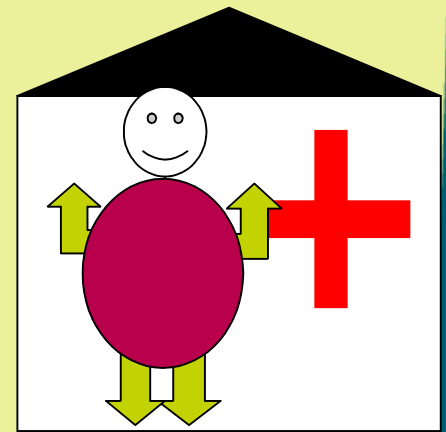
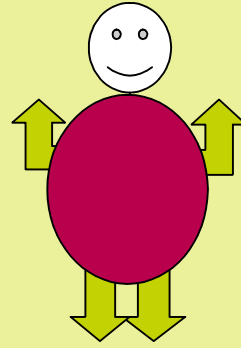
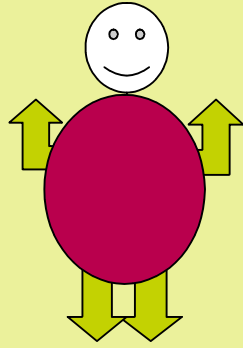
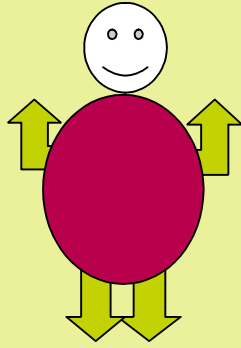
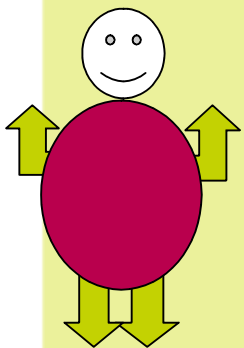
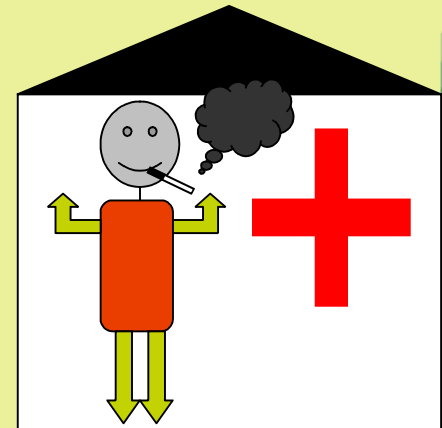
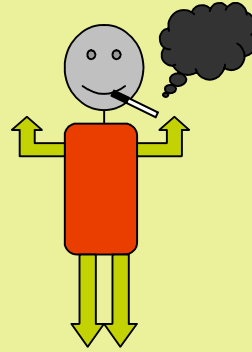
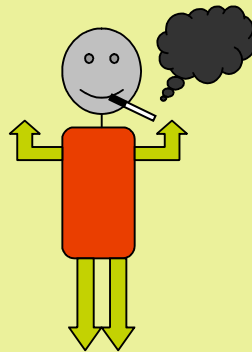
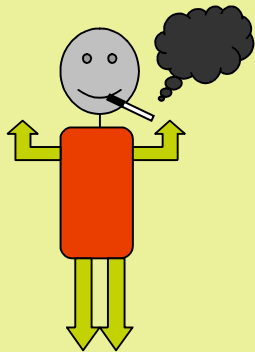
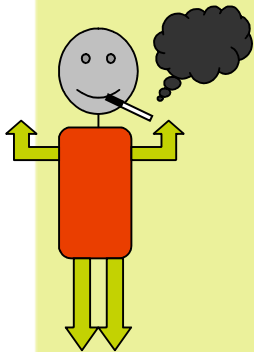
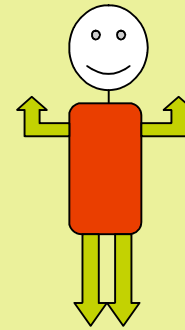
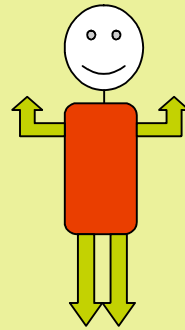
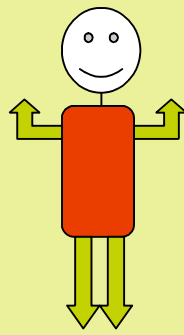
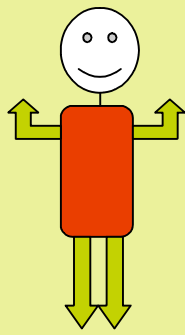
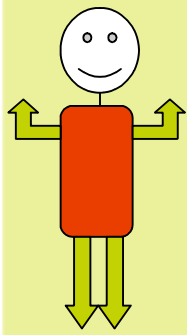
2. Smoking cohort



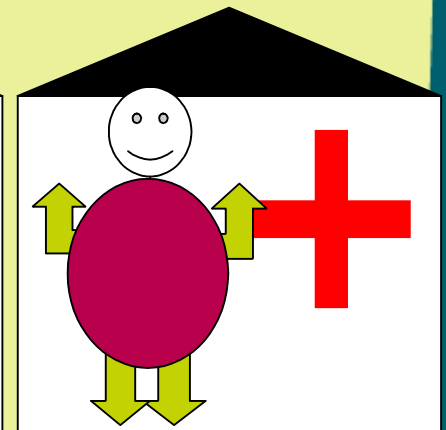
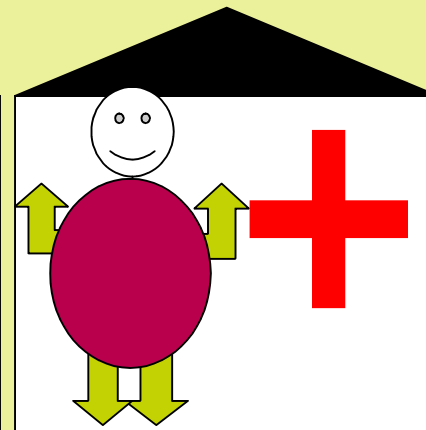
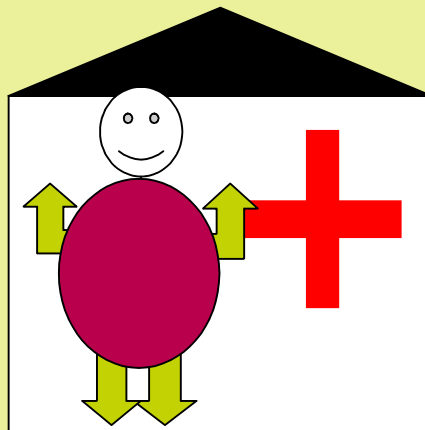
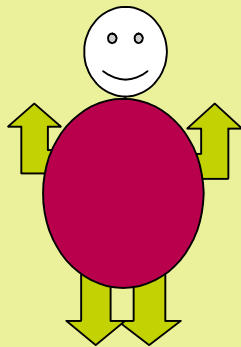
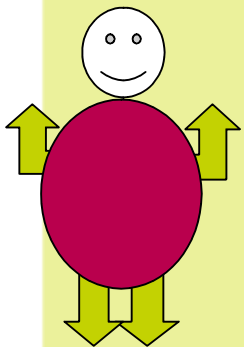
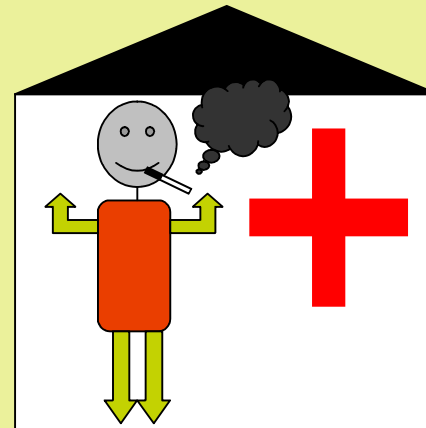
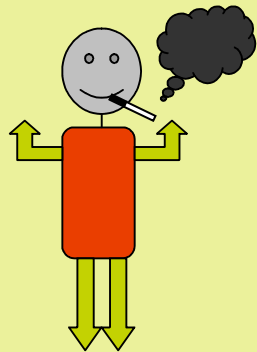
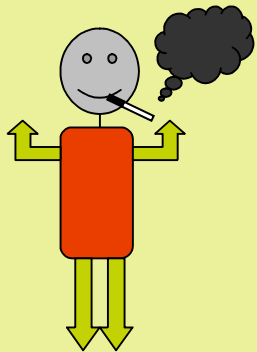
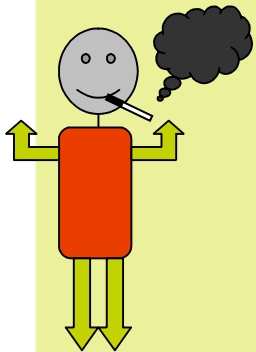
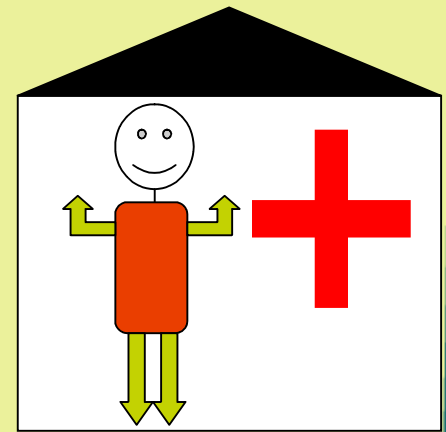
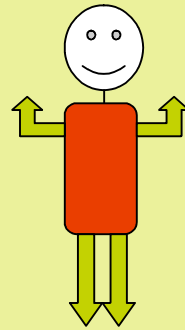
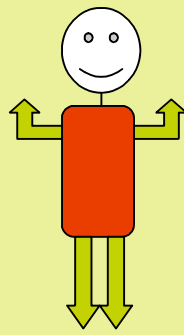
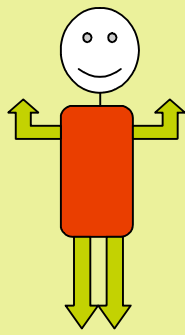
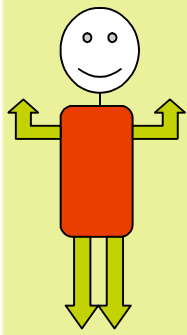
3. Obese cohort



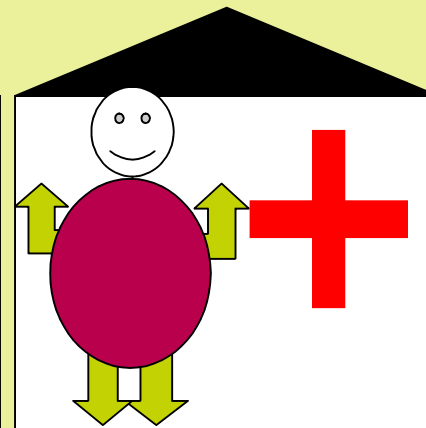
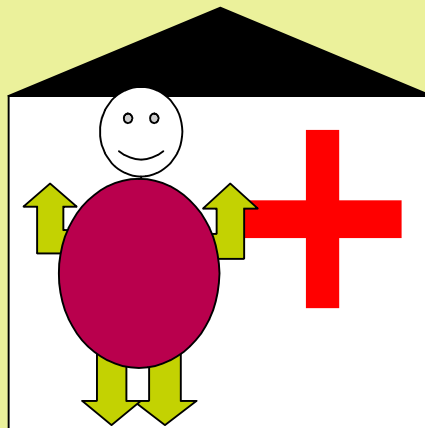
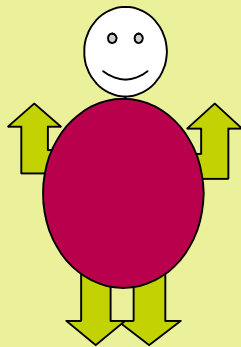
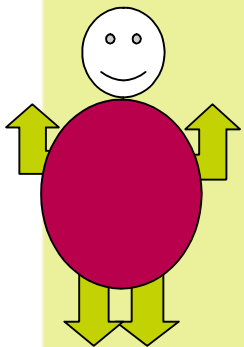
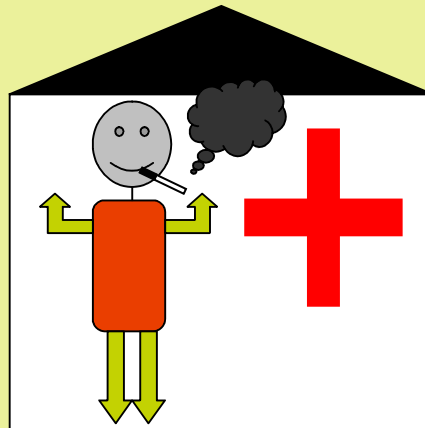
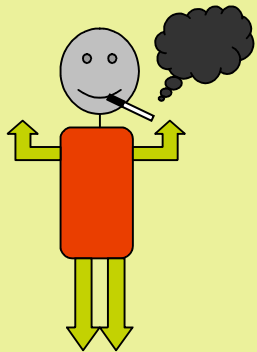
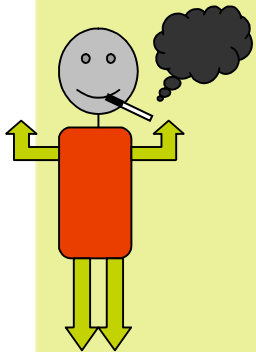
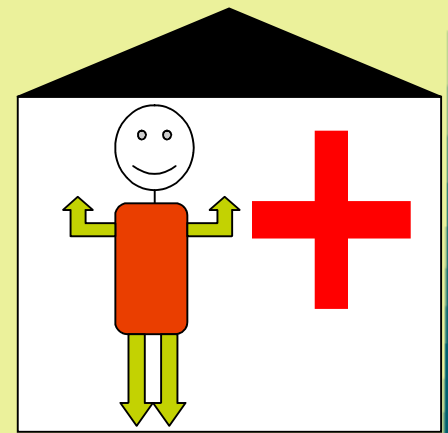
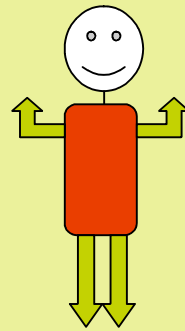
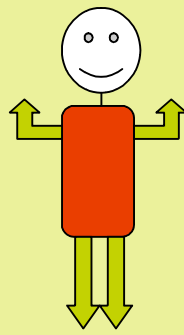
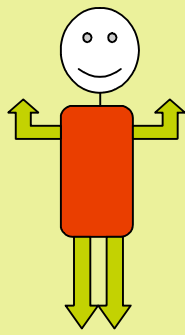
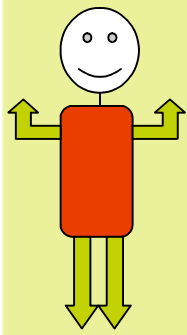
Van Baal et al. 2006

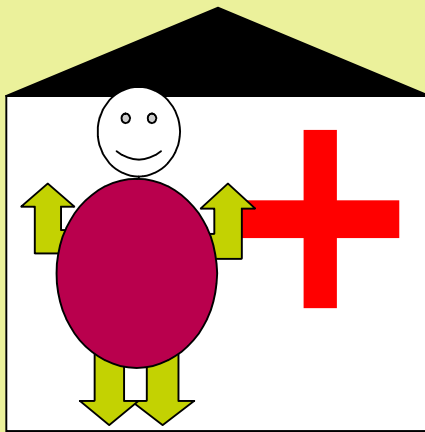
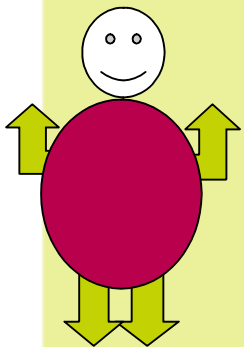
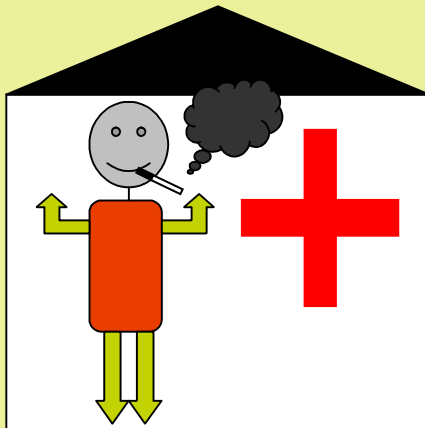
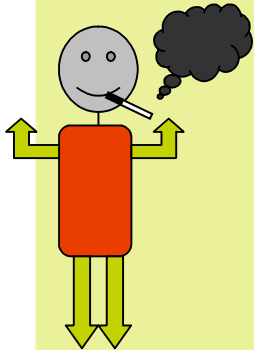
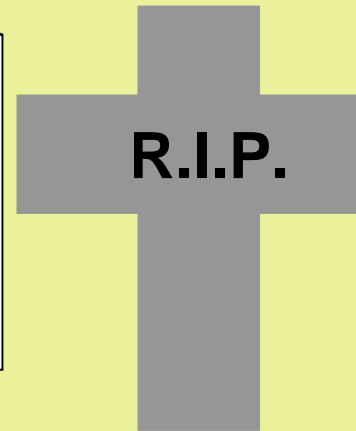
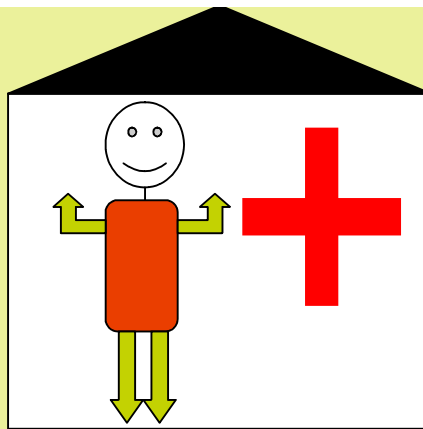
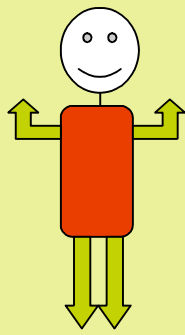
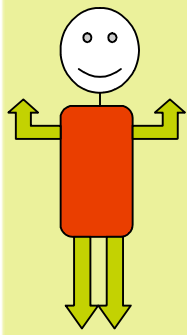


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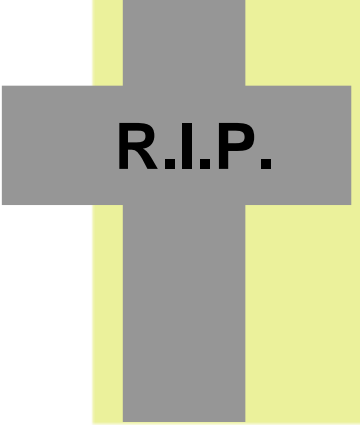
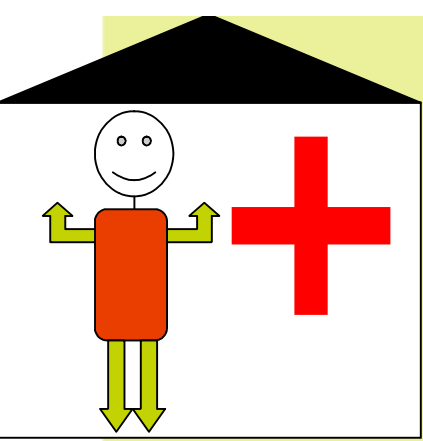


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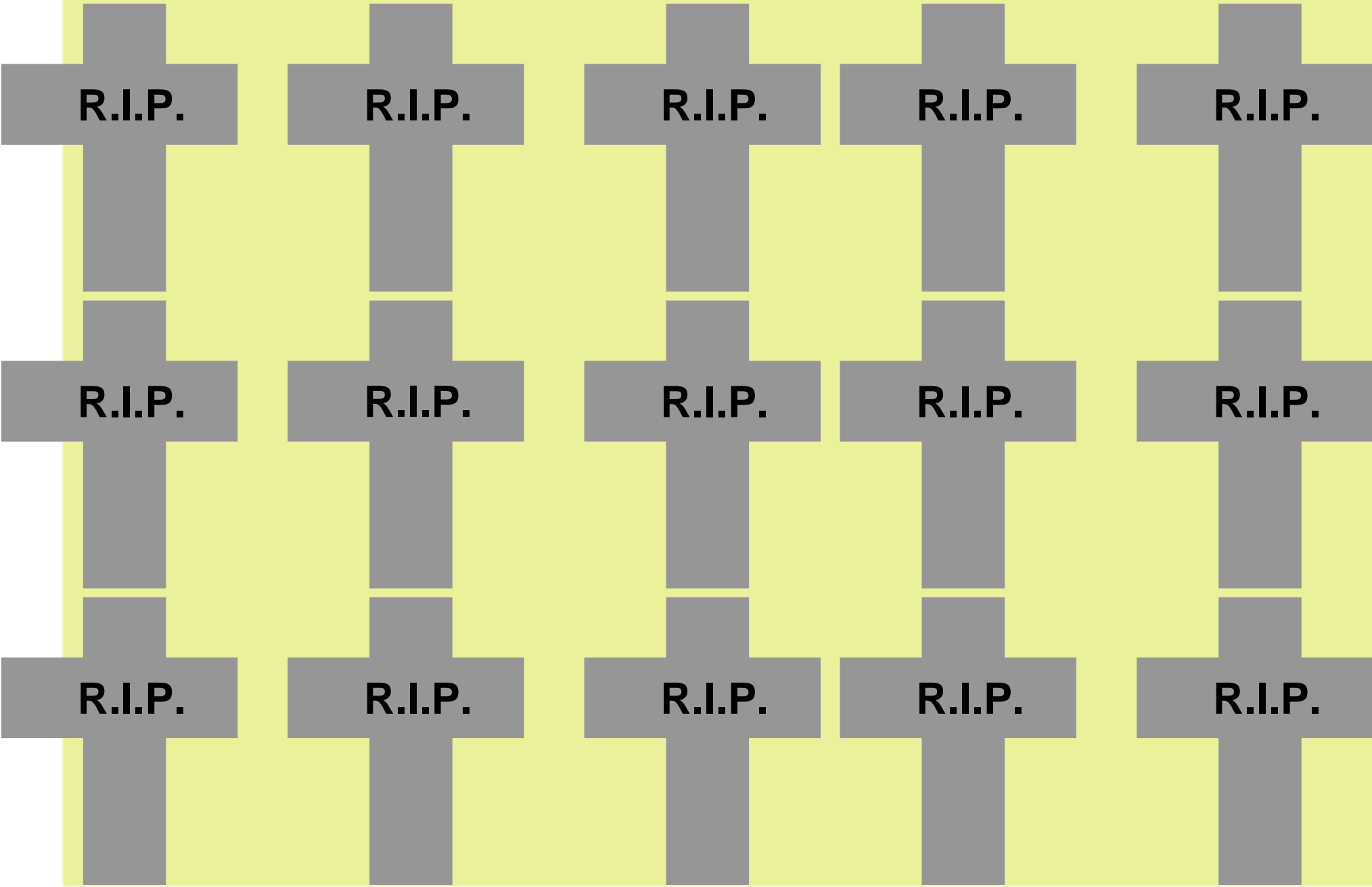




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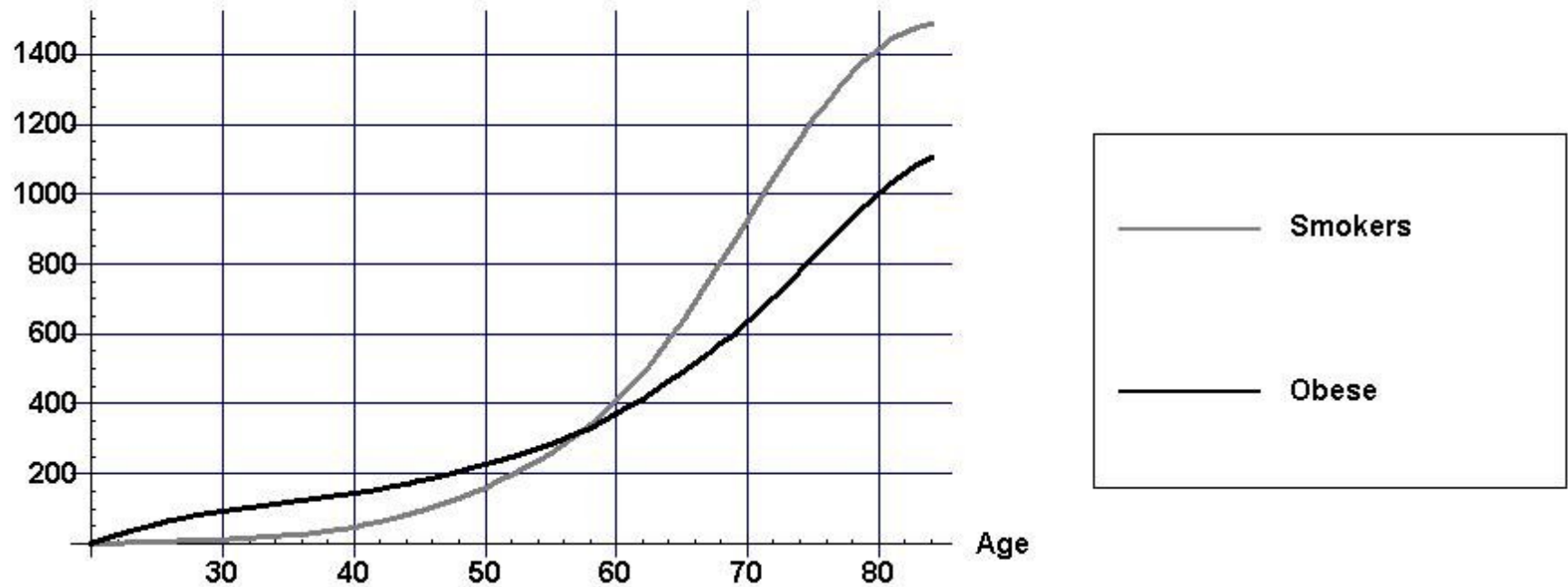
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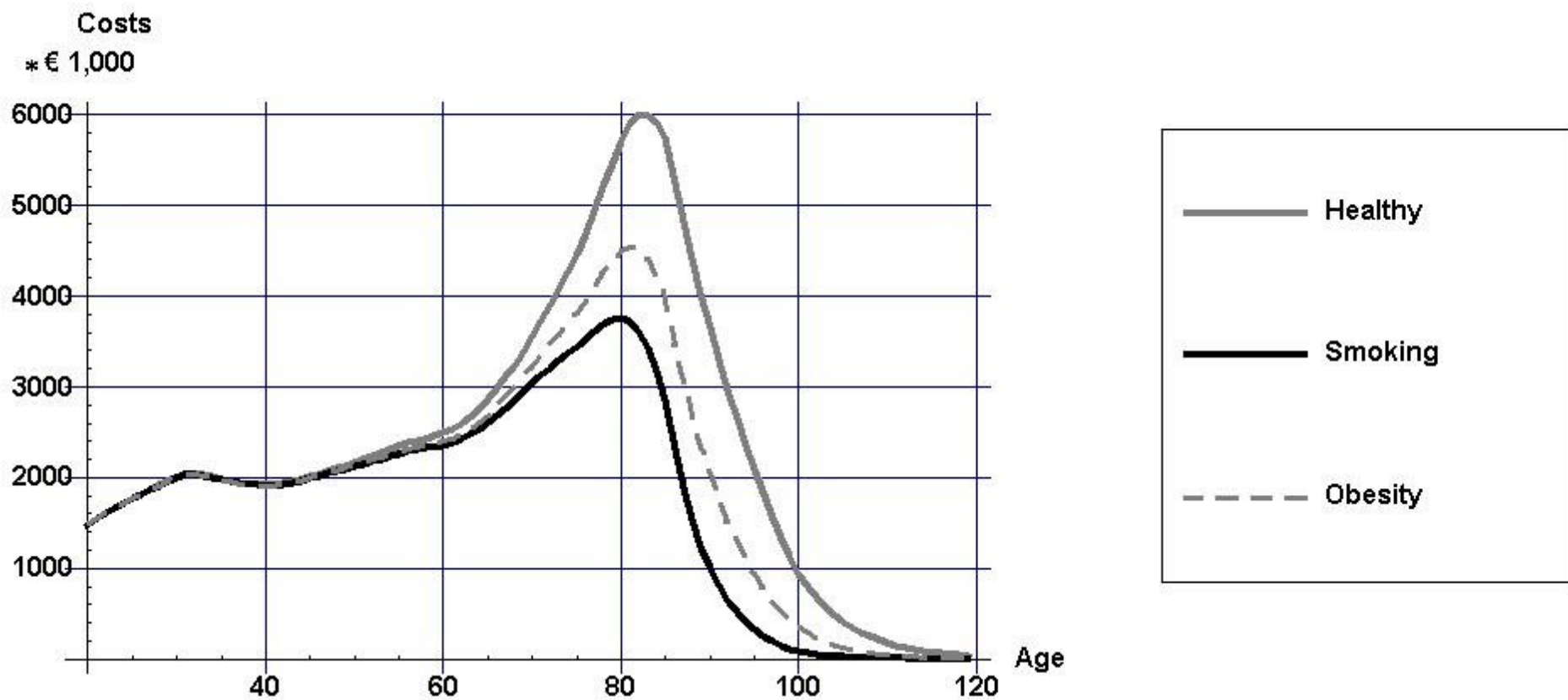
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# Additional health care costs per person per year compared to 'healthy living' cohort

Additional health care costs compared to healthy living people



# Total health care costs of the 3 different cohorts



# Conclusions

- 'Healthy living' people are cheapest per year per person

'Healthy living' cohort has highest lifetime health care costs because they live longest

- Smoking cohort is cheapest because smokers have lowest life expectancy

# Example 3: Lipid lowering treatment for all diabetes patients

- Current use of LLT in Dutch diabetes patients: 30%
- Recent guidelines: nearly 100%
  
- Effect for better adherence to guideline (60% with treatment)
  - 3% reduction of cumulative incidence of CHD
  - 4% reduction of cumulative incidence of stroke
  - Increase in average life expectancy (40-year old 0.4 years)
  - Costs for cardiovascular diseases -1.1%
  - Total health care costs+ 0.5%
  - Cost-effectiveness 14.000 euro/QALY

# Summarizing: Modeling

- Suitable tool to answer different kinds of policy questions
- Forces you to collect (a lot of) relevant data
- Confronts you with inconsistencies in data
- Assumptions are required
- Trade-off between complex and realistic
- Optimal representation of current knowledge
- Assists in formulating evidence based prevention
- Give insights in effects of different types of prevention
- Gives insight in health care costs and cost-effectiveness

# Project team “Chronic Disease Model”

## Supervision:

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## Overweight:

Wanda Bemelmans, Pieter van Baal, Wanda Vos

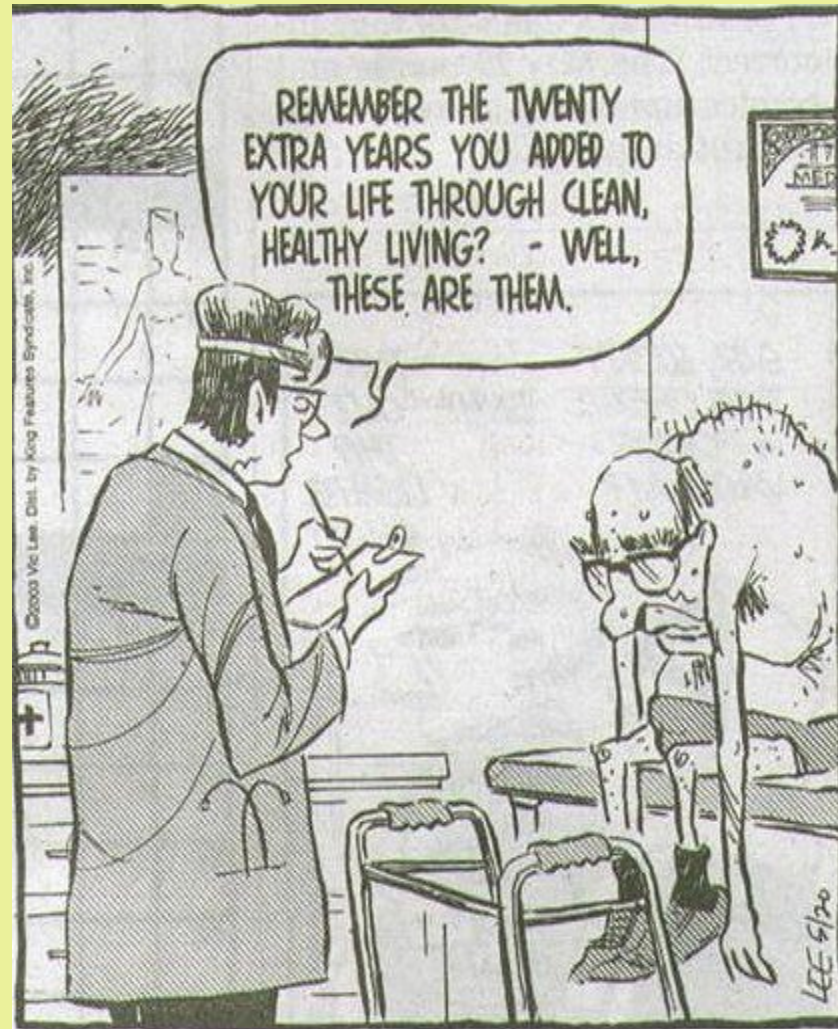
## Diabetes:

Monique Jacobs, Peter Engelfriet, Caroline Baan

## CVD:

Anneke Blokstra, Linda Kok, Monique Verschuren, Jeroen Struijs, Peter Engelfriet

Thank you for your attention !



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# CDM publications

- Jacobs-van der Bruggen MA, Bos G, Bemelmans WJ, Hoogenveen RT, Vijgen SM, Baan CA: Lifestyle interventions are cost-effective in people with different levels of diabetes risk: results from a modeling study. *Diabetes Care* 30:128-34, 2007
- Bemelmans W, van Baal P, Wendel-Vos W, Schuit J, Feskens E, Ament A, Hoogenveen R: The costs, effects and cost-effectiveness of counteracting overweight on a population level. A scientific base for policy targets for the Dutch national plan for action. *Prev Med* 2007
- van Baal PH, Hoogenveen RT, de Wit GA, Boshuizen HC: Estimating health-adjusted life expectancy conditional on risk factors: results for smoking and obesity. *Popul Health Metr* 4:14, 2006
- Struijs JN, Genugten MLLv, Evers SMAA, Ament AJHA, Baan CA, Bos GAMvd: Modeling the future burden of stroke in The Netherlands: impact of aging, smoking, and hypertension. *Stroke* 36 :1648-1655, 2005

# CDM publications

- Feenstra TL, Hamberg-van Reenen HH, Hoogenveen RT, Rutten-van Molken MP: Cost-effectiveness of face-to-face smoking cessation interventions: a dynamic modeling study. *Value Health* 8:178-90, 2005
- Hoogendoorn M, Rutten-van Molken MP, Hoogenveen RT, van Genugten ML, Buist AS, Wouters EF, Feenstra TL: A dynamic population model of disease progression in COPD. *Eur Respir J* 26:223-33, 2005
- Feenstra TL, van Genugten ML, Hoogenveen RT, Wouters EF, Rutten-van Molken MP: The impact of aging and smoking on the future burden of chronic obstructive pulmonary disease: a model analysis in the Netherlands. *Am J Respir Crit Care Med* 164:590-6, 2001

# USE BY OTHER COUNTRIES

- RIVM model tailored to available data in the Netherlands
- Principles are generally applicable
- Relative risks are generally applicable in EU
  - Current proposal for EU-project (EUR)

DYNAMO-HIA

DYNAmic MOdeling for Health Impact Assessment

# DYNAMO-HIA

## Aims:

- Simplified dynamic model needing standard data
- Available through the internet
- Comes with example datasets
- Comes with examples of use

## What can you do with it:

- Assess health impact of policies
- Compare health effects of different strategies for prevention
- Estimate burden of disease

Project has started in 2007 (contact [j.mackenbach@erasmusmc.nl](mailto:j.mackenbach@erasmusmc.nl))

# Assumptions: model structure

- No lag times
- Risk factors act independently
- Mortality in those with a particular disease: age-dependent constant excess mortality above of mortality of those without the disease
- Prevalence / incidence / remission / excess mortality rates should be consistent
- Risk factor prevalence and transition rates should be consistent
- Disease incidence and all cause mortality described by (age-dependent) relative risk